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Evaluation of CAESAR-Lisflood as a tool for modelling river channel change and floodplain sediment residence times.

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Sediment residence time represents the duration of particle storage, from initial deposition to remobilisation, within reservoirs such as floodplains. Residence time influences rates of downstream redistribution of sediment and associated contaminants and is a useful indicator of landform stability and hence, preservation potential of alluvial archives of environmental change. River channel change controls residence times, reworking sediments via lateral migration, avulsion and incision through floodplain deposits. As reworking progresses, the floodplain age distribution is ‘updated’, reflecting the time since ‘older’ sediments were removed and replaced with ‘younger’ ones. The relationship between ages and the spatial extents they occupy can be used to estimate the average floodplain sediment residence times. While dating techniques, historic maps and remote sensing can reconstruct age distributions from historic reworking, modelling provides advantages, including: i) capturing detailed river channel changes and resulting floodplain ages over longer timescales and higher resolutions than from historic mapping, and ii) control over inputs to simulate hypothetical scenarios to investigate the effects of different environmental drivers on residence times. CAESAR-Lisflood is a landform evolution model capable of simulating variable channel width, divergent flow, and both braided and meandering planforms. However, the model’s ability to accurately simulate channel changes requires evaluation if it is to be useful for quantitative evaluation of floodplain sediment residence times. This study aims to simulate recent historic river channel changes along ten 1 km reaches in northern England. Simulation periods were defined by available overlapping historic map and mean daily flow datasets, ranging 27-39 years. LiDAR-derived 2 m DEMs were modified to smooth out present-day channels and burn in historic channel locations. To reduce run times, DEMs were resampled to coarser resolutions based on the size of the channel and historic rate of lateral channel migration. Separate pre-defined coarse and finer channel bed and floodplain grain size distributions were used, respectively, in combination with constructed reach DEMs for model simulations. Calibration was performed by modifying selected parameters to obtain best fits between observed and modelled channel planforms. Initial simulations suggest the model can broadly reproduce observed planform change and is comparable in terms of channel sinuosities and the mean radius of curvature. As such, CAESAR-Lisflood may provide a useful tool for evaluating floodplain sediment residence times under environmental change scenarios.